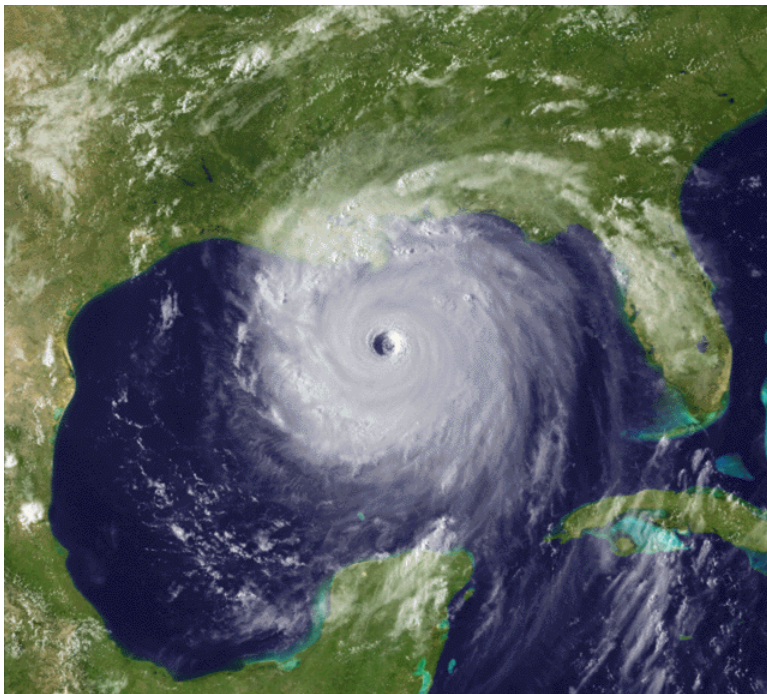


Hurricane Modeling and Prediction Across Timescales at GFDL



Hurricane Katrina, Aug. 2005

Presenter: Tom Knutson

Geophysical Fluid Dynamics Lab/NOAA
Princeton, New Jersey

Key GFDL personnel:

Gabe Vecchi

S.-J. Lin

Morris Bender

Ming Zhao

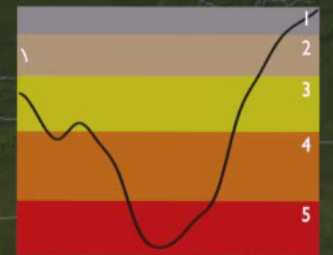
Univ. of Rhode Island:

Isaac Ginis

Hurricane Katrina Coupled Model Forecast

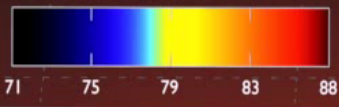
Aug 27 02:30 UTC

Central Pressure / Category

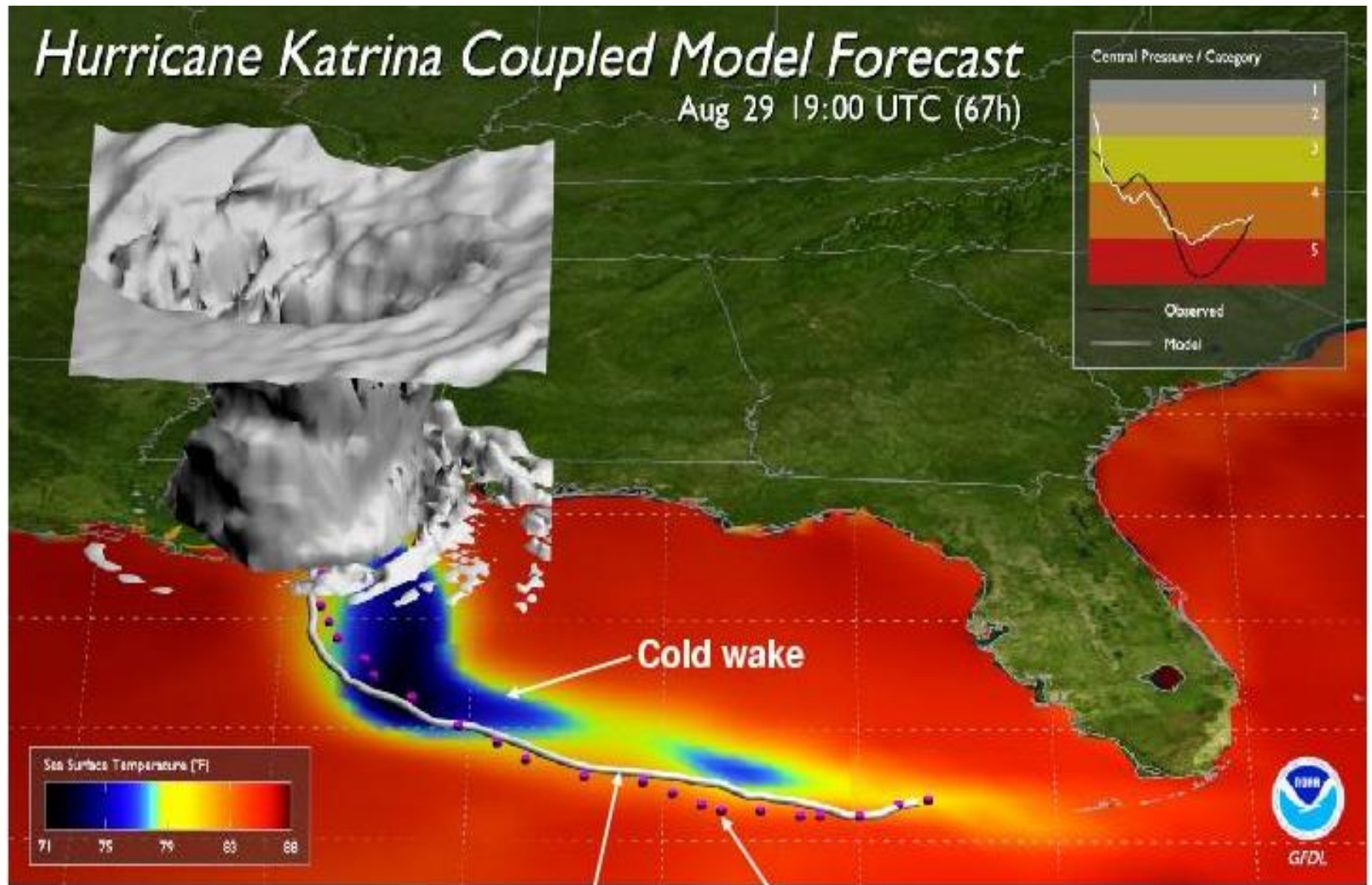


Observed
Model

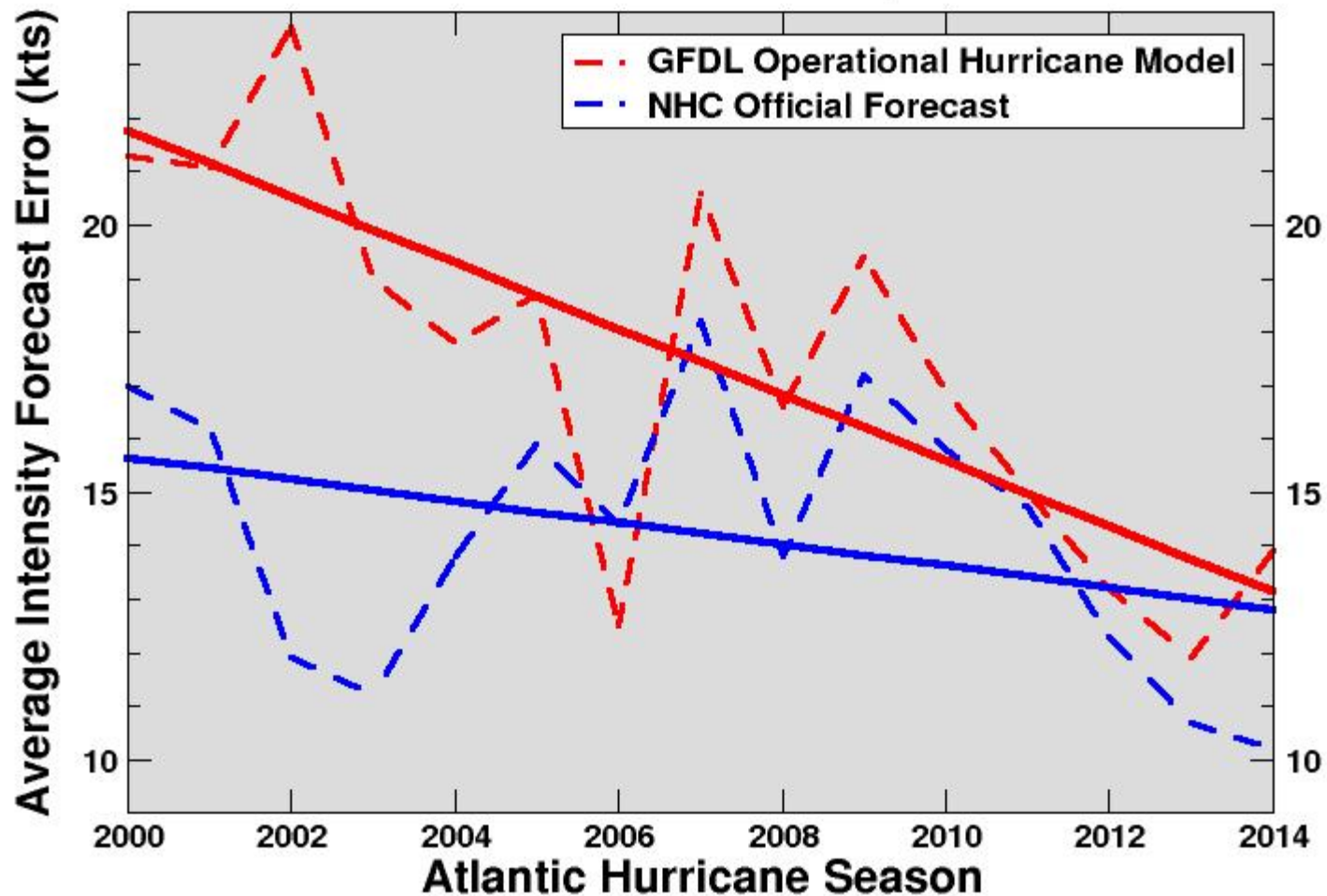
Sea Surface Temperature (°F)



GFDL



Atlantic Basin Tropical Cyclone Intensity Forecast Errors Trend of 48h Forecast Errors, 2000-2014

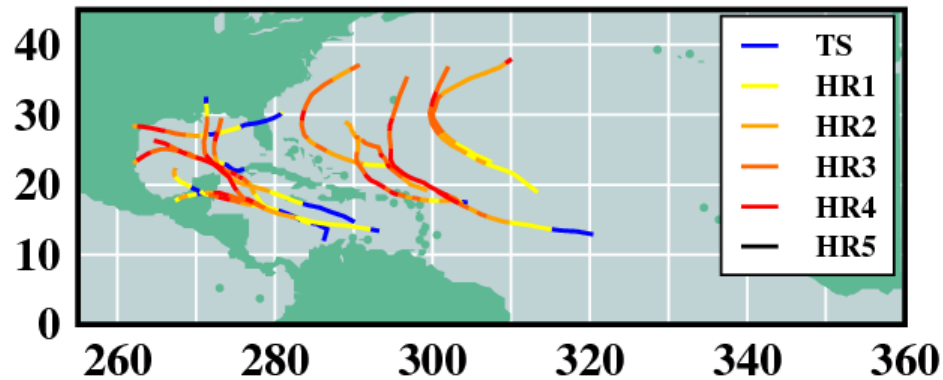


Source: Morris Bender, GFDL/NOAA

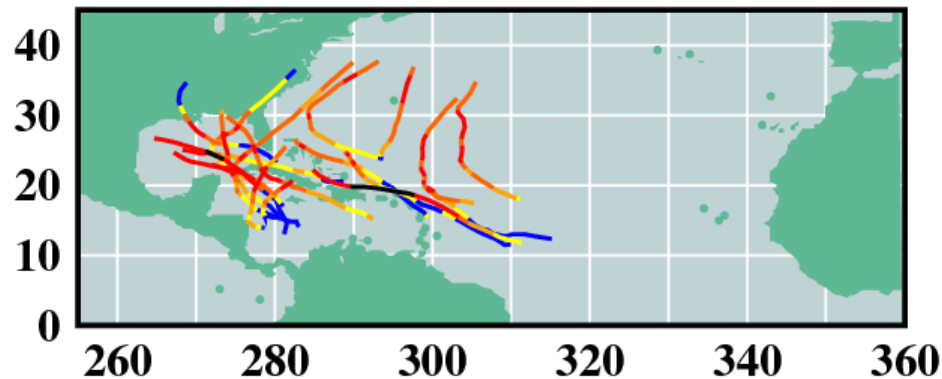
Latest updates:
Resolution
Physics
Initialization

Simulated Category 4 & 5 hurricane frequency under global warming conditions

Present-Day Simulation: 14 storms



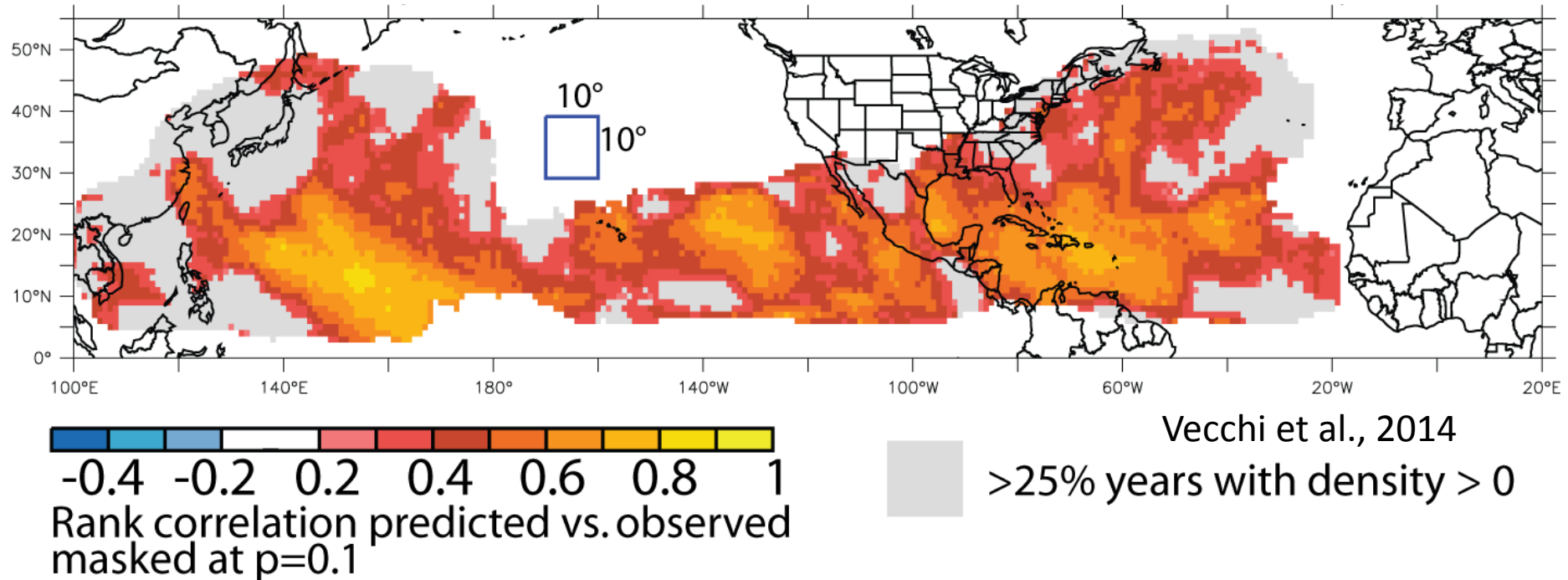
CMIP5 Late 21st century: 19 storms



GFDL hurricane model downscaling: 27-year samples

Source: Knutson et al. (*Journal of Climate*, 2013).

Pioneering seasonal prediction of regional tropical storm activity

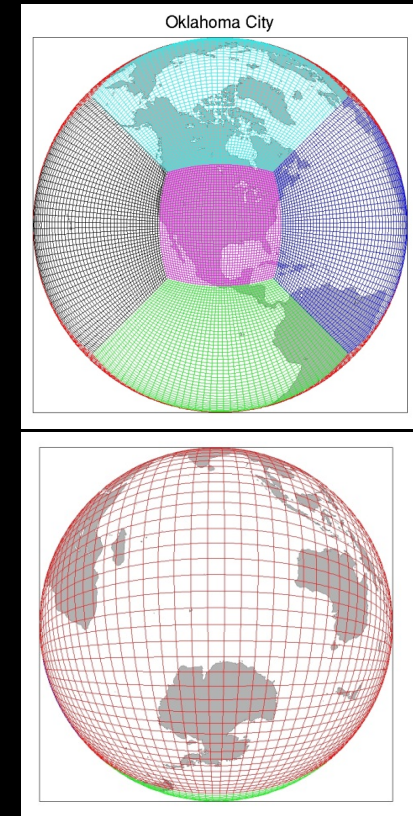
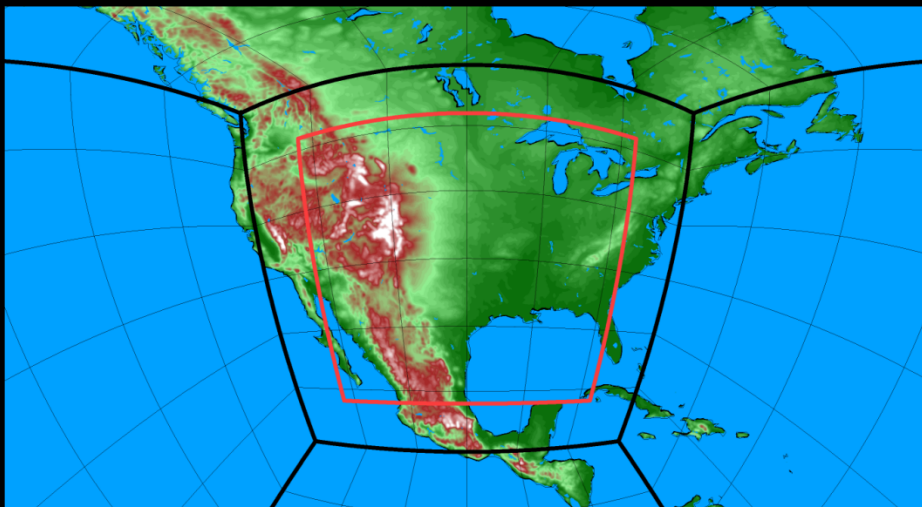


Red/Orange regions indicate where the model system has retrospective forecast skill (1981-2011), July 1 initialization times.

Source: Vecchi et al., *Journal of Climate* (2014).

Strategies for variable resolution on the cubed-sphere

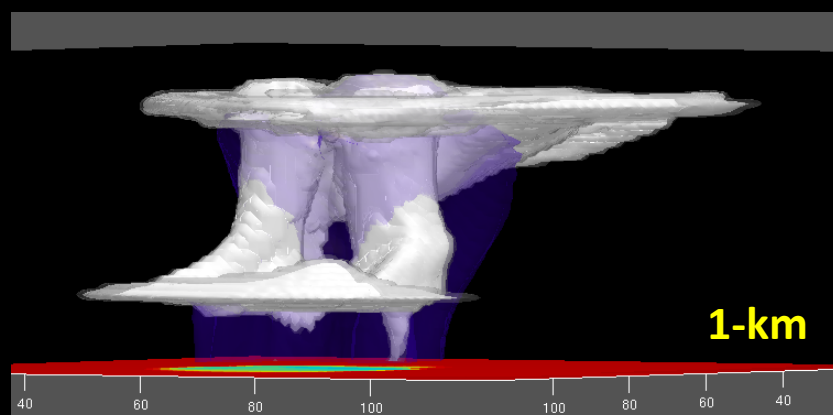
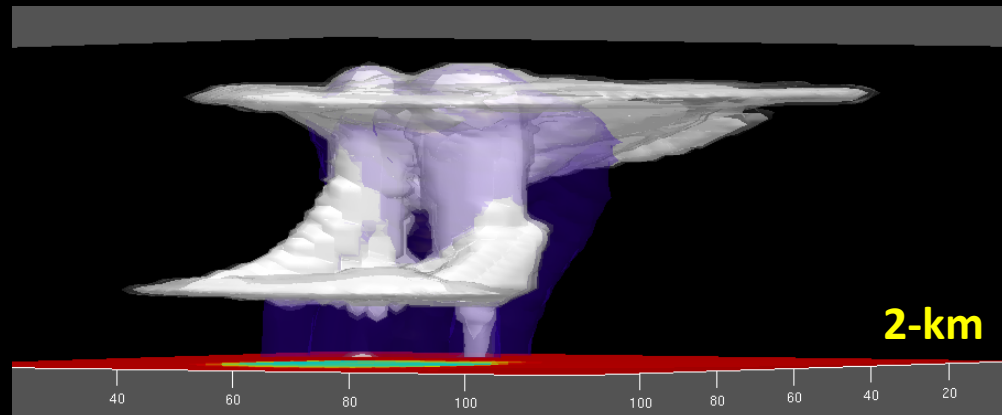
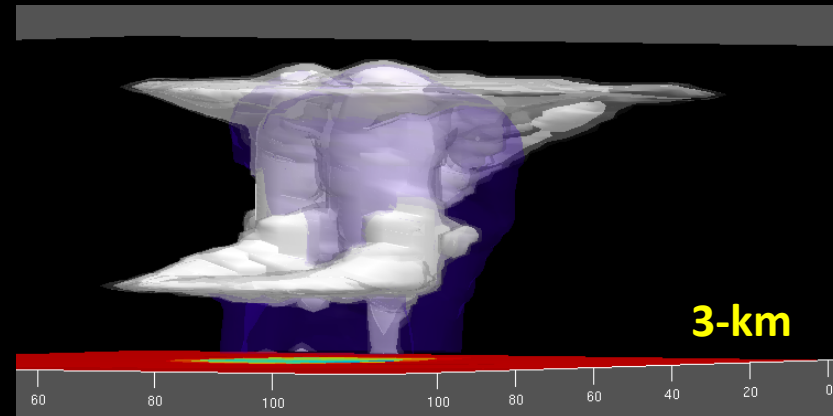
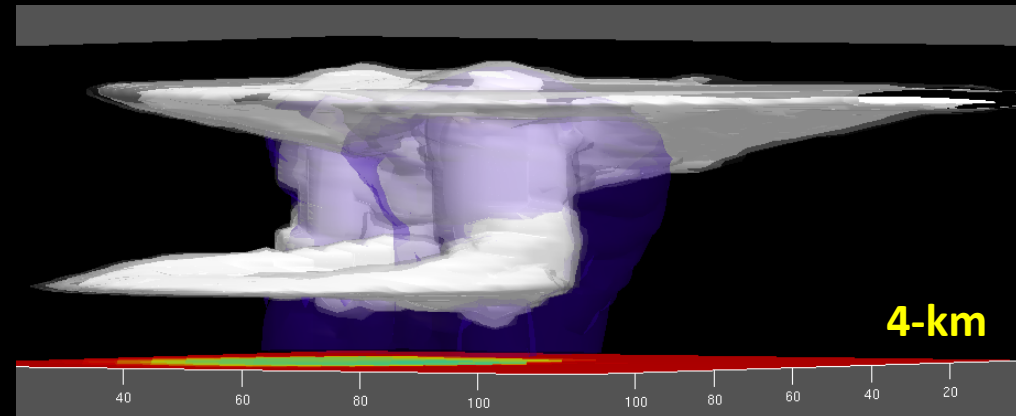
- 1) Grid **stretching** (via analytic transformation)
 - Moderate stretching (2.5 x) maintains integrity of global circulation - use this for long term predictions
 - Aggressive stretching (20 x) – use this for short term severe weather predictions (super-cell & tornadoes)
- 2) 2-way **nesting** (Harris and Lin 2014)
- 3) Combination of the “**stretching**” and “**nesting**”



Example:

- ~ 3 km without the nest (black)
- ~ 1 km with a 2-way nest (red)

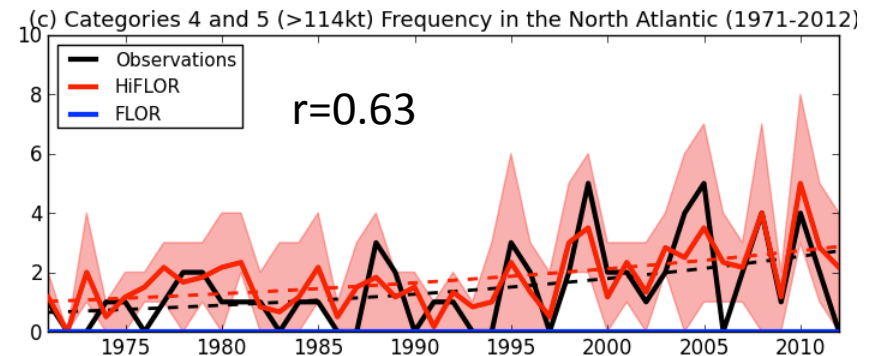
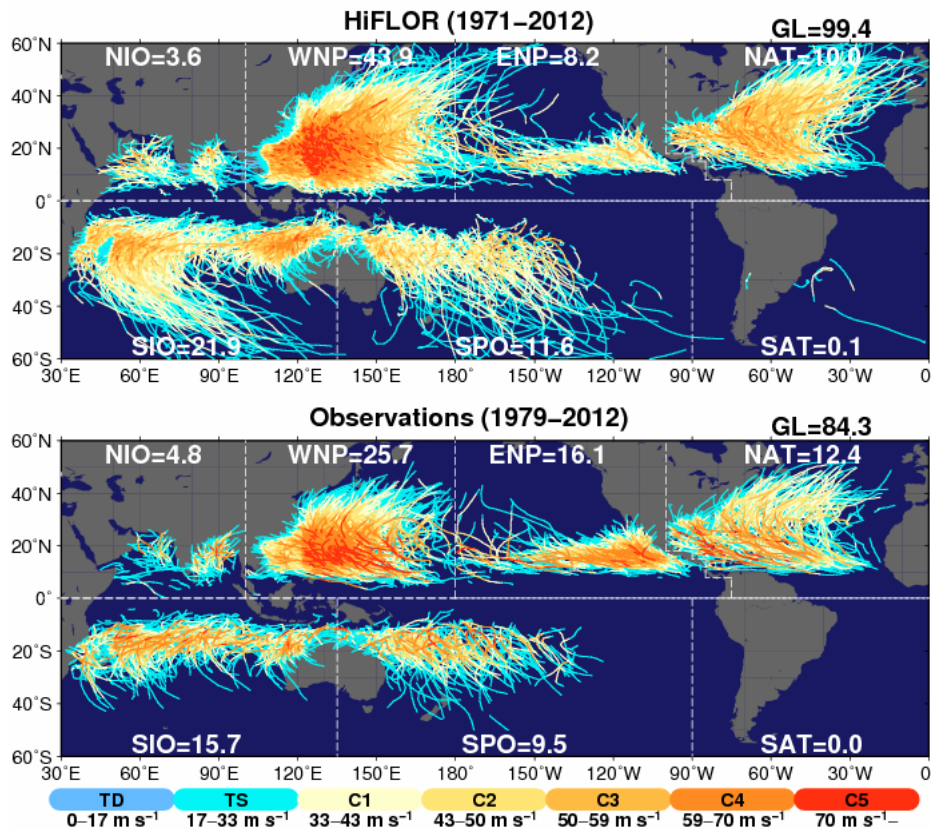
Simulations of tornado-like vortices within super-cell storms using GFDL's stretched FV³



Lin and Harris (2014/2015, manuscript in preparation)

A new GFDL forecast model for seasonal tropical cyclone predictions, including intense (Cat 3-5) storm activity:

HiFLOR model run at 25km grid-spacing and SSTs restored[#] to observations

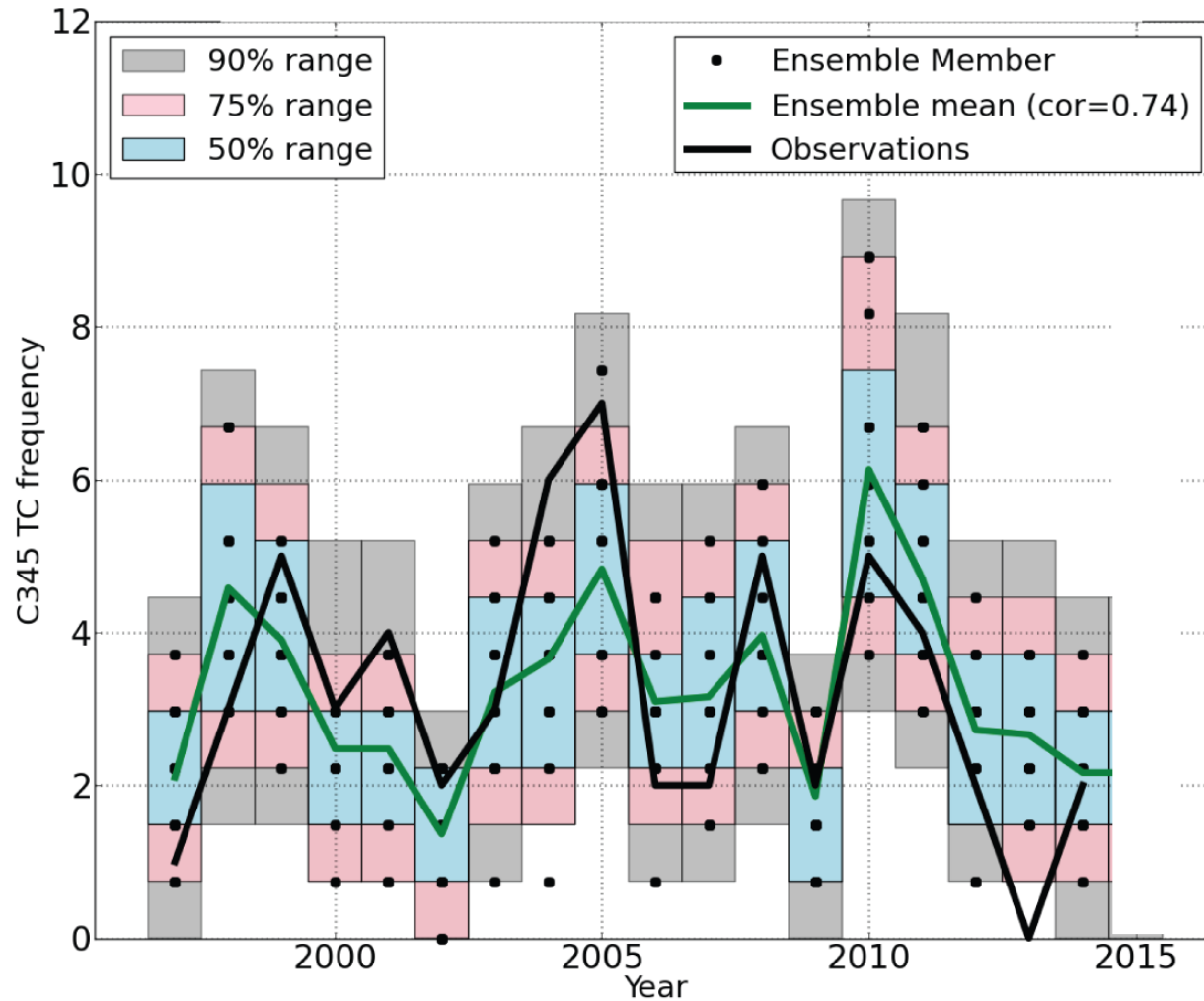


[#]Restoring timescales: 5 or 10 days.
 r = rank correlation

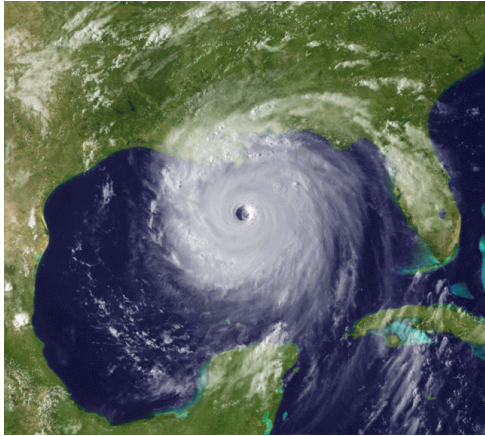
Source: Adapted from Murakami et al., submitted to J. Climate, 2015.

HiFLOR 1-July-initialized seasonal predictions of Atlantic Cat. 3-4-5 Hurricanes

(2015 has been provided to Seasonal Hurricane Outlook Team)



Updated from Murakami et al. (2015)



Summary:

NOAA has been engaged in extensive numerical model development and research toward a predictive understanding of hurricane activity on timescales from hours to centuries.

Focus: connecting fundamental research with improvements in predictive capability.